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THE USE OF CONCRETE BLOCKS IN BUILDING CONSTRUCTION

BY

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THESIS

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USE OF CONCRETE BLOCKS IN BUILDING CONSTRUCTION.

Introduction.

It has been the object of this thesis to discover if possible one or more methods of applying the cement block to building construction in a way that will render it successful and desirable both aesthetically and constructionally. It is also desirable to open up a field for cement blocks which will be strictly its own and to accomplish ends which could not be attained by the use of other materials. A number of opinions on the subject of cement blocks both pro and con have contained statements to the effect that a cement block should not be utilized to serve the same purpose as a block of stone, either in a rock face or plain surface and that therefore the attempt to build buildings of cement blocks to imitate stone buildings should be abandoned. The authors of such articles and statements seem to have had abundant cause for arriving at such a conclusion, judging from the character of work produced by nearly all block manufacturers today. Foremost among those who have advanced opinions along this line is Mr. Louis H. Gibson, Architect, of Indianapolis. In his article in the March number, 1906, of the Municipal Engineering magazine and also in a paper read before the convention of the National Association of Cement Users at Milwaukee, he seems to have hesitated to recognize the cement

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block idea and said that he could not afford to encourage and foster the industry. He said in fact at Milwaukee that he had never seen an artistically successful structure executed in cement blocks. He seems, however, to have arrived at a different conclusion for in another lengthly article in the May number, 1906, of the Municipal Engineering magazine he recognizes the possiblility of the cement block. The change in his views seems to have been brought about by the remarkable success attained in certain buildings such as: Canadian Bank of Commerce, London, Ont., artificial stone block construction; the Gate House, Ontario, Power Company—Niagara Falls, where artificial stone block was used for facing; Marter's House, Toronto; Carnegie Library, St. Cortherines, Ont.; The Central Methodist Church, Toronto, where artificial stone has been employed for trimming. These buildings were executed by Mr. Charles G. Watson and from the photographs they appear very successful and show that work of a high order may be produced and also that cement can be successfully carved the same as stone. Mr. Gibson emphasises the importance of good careful and conscientious work and that, "every step and detail must carry along the same high quality of intent, sincerity and integrity." He states this as "the difference between the prosaic, common, low-down view and the view of the idealist that makes the difference between the ordinary ugly cement block work and the splendid expression which we see in these buildings." After seeing these buildings there is no longer any doubt but that cement may be cast into blocks which serve every intent and purpose of blocks of stone both

artistically and constructionally. And as blocks of cement it is necessary that buildings of cement blocks shall be designed as block structures, that is stone upon stone and not as monolythic structures such as result from the use of reinforced concrete. In this point lies the greatest objection to the cement block from the laymans point of view if not from that of the architect. For the thought immediately arises that it is an imitation of stone which is at once distasteful and repulsive. This, however, is scarcely a fair conclusion for the fact that certain well known architectural forms were first worked out in stone is no reason why they should not be executed in another medium so analogous to stone in both texture and in its inert composition. In fact any system of block construction is entitled to employ these forms. We have watched terrecotta userp the prestige of stone in every detail known to the classics and have said nothing, and yet terrecotta construction comes far short of being a true block construction. It is not desired to convey the idea that cement blocks are never made to imitate stone for it was the cement block with an imitation rock face that first became a commercial product that started an industry in this country which has grown with a rapidity scarcely equalled by anything. It is this counterfeit which has won the cement block its unpopularity with both architects and other people of taste. In the first place because the average product was not even a fair imitation. In many cases a stone face has not been used in making a mould. Again in order to attract the practical public by their cheapness the manufacturers have used such a poor mixture as to

render them of a coarse bluish grey color with absolutely no life or texture not to speak of their bad constructional features. And even in a few cases where a fairly perfect rock face has been produced the effect of the wall is rendered anything but pleasing by the constant use of one single mould thus resulting in an exceedingly cheap and monotonous repetition. The whole scheme of attempting to imitate a rock face is bad. A true rock face can never be produced in cement as it is in stone for a rock face in stone is made by striking off the edges of the stone to a line and that cannot be done in cement for cement will not break off but will simply crumble under the tool and produce an ugly ragged chewed-up effect.

As has been stated, a cement block building is entitled to all the motives of stone construction and should conform to all its laws but it should always be remembered that the blocks themselves have been either moulded or carved and not broken or chipped off. When this fact is clearly understood and lived up to the cement block will have its place in the field of construction just as truely as has brick or terre-cotta.

There is in the mind of the writer no reason why block construction cannot with advantage be coupled with reinforced concrete construction in the same building. There are many cases where the main walls of the building could be built of blocks while certain parts of the design such as ornamental balconies, brackets, porch columes, lintels, beams, etc., could be better and more cheaply poured into built-up forms with the use of whatever reinforcement was necessary. In

fact a system of fire-proof construction for residences might be employed which would not only be the best known fireproof construction but would have the additional advantage of being comparatively cheap. With this end in view the accompanying drawings on page 11 were made to show a possible fire-proof construction for an ordinary residence of concrete blocks.

TEXTURE.

It is the belief of the writer that the displeasing effect of the ordinary cement block that we see today is due very largely to the lack of texture. Texture and color are the things that distinguish one plain surface from another. Where a poorly mixed facing of dark cement and coarse colorless sand is pressed against a smooth iron surface the effect is bound to be bad. If, however, a facing is used consisting of white sand and as little cement as will properly adhere the particles of sand, and enough water to make the mixture adjust itself readily, the facing produced will be smooth white and full of life.

A great many block makers depend upon the facing mixture to render the blocks impervious and unless there is some other scheme used for keeping out the water it is necessary to use a comparatively fat mixture for the facing.

COLORING.

There are on the market a number of different colors

which may be mixed into the cement and sand of the facing of a block. For example the Samuel H. French Company of Philadelphia sent samples of red, blue, brown, black, and yellow. The same company manufactures a green but which they do not guarantee. Neither do they guarantee their blue as it is affected more or less by exposure to the elements. These as all successful cement colors are mineral oxides and come in powder form. They are comparatively cheap, the prices of the Samuel French Company being as follows:

		In bbl.lots Per 100 lbs.
French's Cement	Black	$ 6.66
"	Blue	16.00
"	Brown	2.00
"	Red #985	13.33
"	Red	1.33
"	Yellow	4.66

The prices stated are the list prices and discounts are allowed according to quantity.

A number of briquettes were made by the writer to determine the relative intensity of the different colors mentioned and also if possible to determine their effect upon the strength of the cement. The weight of the sand and cement was so proportioned as to make the equivalent of a two to one mixture of sand and cement by volume. The following table gives the results of the tests:

Briquette		Cement	Sand	Coloring	Percent Coloring	Tensile Strength in lbs.per sq. in.
RED	1	29	71	5	5	138
	2	29	71	1	1	224
	3	29	71	.25	.25	236
BLUE	1	29	71	4	4	364
	2	29	71	2	2	286
	3	29	71	.5	.5	203
BROWN	1	29	71	5	5	190
YELLOW	1	29	71	4	4	189
	2	29	71	2	2	178
	3	29	71	.25	.25	196
BLACK	1	29	71	3	3	175
	2	29	71	1	1	152
	3	29	71	.25	.25	180

These tests show that as the cement sets the intensity of the color is diminished to about one-half what is was when the water was first added. Red, black, and blue are much stronger colors than the yellow or brown.

The tests for strength were of little value on account of the small number of briquettes tested and it was found that the small variation in the amount of coloring matter did not produce a corresponding variation in strength. It is, however, very noticeable that the blues tested much higher than any of

the other colors and the more blue there was added the higher the tensile strength. There is probably some relation between this and the fact that a cement block with a facing containing blue coloring matter was found to be absolutely impervious to moisture.

DESIGN FOR A CONCRETE BLOCK HOUSE.

This design consists of two floor plans and a front and side elevation of a small two-story cottage. The plans were published by R. C. Spencer, Jr., in the June number,1905, of the House Beautiful magazine and were drawn for frame construction. The elevations were designed by the writer for a cement block construction using a tile roof. The first story is of blocks with an absolutely plain face and the second story, including a band around the first story openings, of blocks with a design on the face which works up into an all-over pattern in colors.

In making the blocks for such a house the facing should be made of very white sand using a little yellow ochre to give them a warm tone. For the pattern, blocks of the type described on page 15 would probable give best results.

COMPARATIVE COST OF CONCRETE BLOCK CONSTRUCTION.

At this stage in the industry it is almost impossible to obtain any information regarding the cost of concrete block construction that would be at all general. At least not from

local manufacturers for the cost depends upon the rapidity with which the blocks can be made; the amount of cement used; the care taken in curing besides the cost of sand, gravel, and cement. In sections where sand and gravel may be had for the hauling the price of blocks must necessarily be lower than in a locality like Urbana where it is necessary to ship gravel and sand from a distance. One plant in Urbana with a press machine makes six hundred blocks per day while another in Champaign is making two hundred with a tamp machine, both employing about the same number of men.

Probably the best and the most reliable information on this subject is to be found in a paper by Mr. Newberry mentioned in detail further on. He writes as follows:

"In general it may be said that a factory producing the equavilent of 600 eight-inch blocks per day will require a force of about twenty-five men, at probably average wages of $1.80 per day. Other necessary expenses are power, water, management, sales, advertising, office rent and supplies, repairs, etc. A fair estimate of daily expenses of such a factory would be:

Materials for 600 blocks @ 10¢ each....	$ 60.00
Labor, 25 men @ $1.80.....	45.00
Repairs.....	10.00
Office and miscellaneous expenses.....	20.00
Total	$135.00

or 22.5¢ per eight-inch block. With a fair margin for interest on capital and reasonable profit, eight-inch and twelve-inch blocks, of first-rate quality, may be

sold at prices of thirty cents and forty cents each, respectively, at factory. Contractors ordinarily charge ten cents each for laying cement blocks. With blocks selling at forty cents at factory, and adding five cents for teaming and ten cents for laying, twelve-inch blocks laid,—making two cubic feet of wall each,—would cost fifty-five cents or 27.5 cents per cubic foot."

He adds that where pressed brick are used for facing, the cost of brick work per cubic foot is almost twice that of concrete blocks.

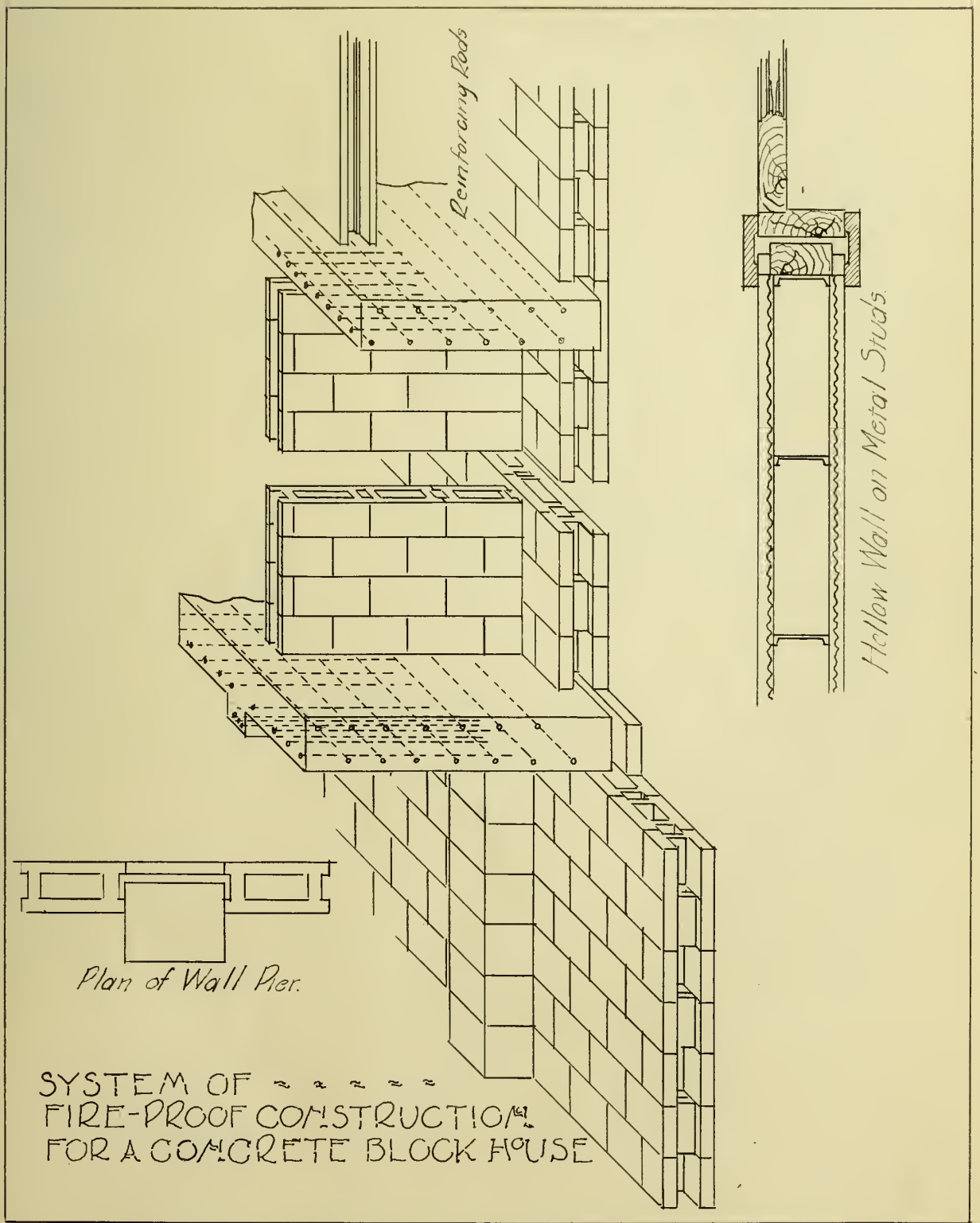
Mr. Newberry was quoted a price of $2.00 each for rock face blocks of natural sand stone, at Cleveland, of the same size and shape as the eight-inch concrete blocks selling at thirty cents each. Furthermore, he says that in sections where sand and gravel are abundant, eight-inch blocks of 1-1/3 cubic feet can be made for fifteen cents each and laid up for five cents more making total cost in wall of fifteen cents per cubic foot, or about one-half the cost of common brick.

Judging from the present increase in the price of lumber, one is lead to believe that the cement block will become a recognized building material and before it does so, people will have demanded a better block than is being made by most manufacturers. Prices will then naturally adjust themselves to something near a standard.

EXPERIMENTS.

A number of experimental concrete blocks were made by the

writer for the purpose of ascertaining points in regard to color, texture, and permiability. They were made according to the following specifications: (See following page)



SYSTEM OF ~ ~ ~ ~ ~
FIRE-PROOF CONSTRUCTION
FOR A CONCRETE BLOCK HOUSE

SPECIFICATIONS FOR SINGLE CONCRETE BLOCK GENERAL.

All blocks shall be made by the dry process except where otherwise specified and the material in every case to be thoroughly mixed dry before any water is applied. Where cement is spoken of it is understood to mean Atlas Portland Cement or a brand of Portland Cement equal to Atlas in every respect. All blocks shall be hollow and shall measure 8" x 16" on the face and 8" in thickness.

The morter when put into the machine shall be as wet as possible and still allow the blocks to be removed from the machine at once. All blocks shall be thoroughly and uniformely tamped the way they are laid in the wall. After the blocks have been removed from the machine they must be protected from the sun and wind and unless otherwise specified shall be frequently spinkled for at least ten days.

In every case the face of the block shall be flat with no bevelled surfaces or rock face-the corners and edges made clean and sharp.

BLOCK NO. 1.

Body and Face of Block:- Cement 1, sand and gravel 4. Gravel on face to be screened through a screen with a 1/2" mesh. Face to be wood troweled as soon as the block has hardened sufficiently to withstand the pressure.

BLOCK NO. 2.

Body of Block:- Cement1, hydrate lime 1/2, sand and gravel 6.

Facing:- Cement 1 1/2, hydrate lime 1/8, sand 5, Surface untouched.

BLOCK NO. 3.

Body of Block:- Cement 1, sand and gravel 5.

Facing:- Cement 1, fine sand 2, The body of the block shall be put into the machine first and thoroughly tamped with plenty of water using a thin board ~~and a~~ the exact size of the face to fill the space to be occupied by the facing. Then pull the board out and pour in the facing mixture which has been thoroughly mixed with sufficient water to allow it to be conveniently poured. After the block has dried sufficiently to allow it to be removed from the

mould, take up small pebbles and throw them on to the surface with a paddle or small shovel until the surface is uniformly covered.

BLOCK NO. 4.

Body of Block:- Cement 1, sand and gravel 5, water-proofing compound 3% of volume of cement.

Facing:- Cement 1, white sand 3, waterproofing compound 3% of volume of cement, Add enough yellow ochre to tint face two shades darker than would be desired when the block is dry.

Waterproofing compound to be thoroughly mixed dry with cement and sand before any water is applied. Surface wire brushed as soon as dry enough.

BLOCK NO. 5.

Body of Block:- Cement 1, sand and gravel 5.

Facing:- Cement 1, white sand 3 yellow ochre same as in block No. 4. Surface wire brushed same as in block No. 4.

Block No. 6.

Same as block No. 5 except red oxide to be used for coloring instead of yellow ochre.

BLOCK No. 7.

Entire block to be:- Cement 1, sand 2, crushed quartz 4. Surface to be wire brushed after it has begun to set.

Note:- Crushed quartz may be had at the Sheldon Brick Co., in Champaign.

Block No. 8.

Body of Block:- Cement 1, sand and gravel 5.

Facing:- Cement 1, marble dust 3, Yellow ochre sufficient to tint facing two shades darker than would be desired when block is dry. Surface wood troweled.

BLOCK NO. 9.

Body of Block:- Cement 1, sand 2, Lime Stone screenings (coarse) four.

Facing:- Cement 1, sand 1, Lime Stone screenings (fine) three, Surface wire brushed.

PATTERN BLOCKS.

Besides the blocks included in the above specifications, there were two attempts made to produce a design on the face of a block so that when such blocks are laid in the wall they will produce a continuous all-over pattern.

The first of these consisted of a plaster mosaic design inlaid in the face of the block with two units of the design on each block, each block measuring eight inches by sixteen inches. The colored plaster of which the design is made is an invention of Prof. N. A. Wells of the University of Illinois. The thin sheets of colored plaster were first boiled in parafine before being cut into pieces. The bits of plaster composing the design average about one square inch in area and about one-eighth of an inch thick. The design was first drawn on heavy paper and the bits of plaster pasted to it, face down. Then the design was placed in the cement block machine, paper side next to the face plate, and a facing mixture of white sand in a proportion of one to one was poured over the plaster. Next the body mixture of cement 1, sand and gravel 4, was put into the machine and thoroughly tamped. The block was allowed to remain in the machine until the facing mixture had set sufficiently to allow the block to be removed. After the block has had time to set it will be exposed to the weather for a sufficient time to ascertain the effect of rain, freezing and thawing. It is believed that the parafine in the plaster will resist the inflow of water and if so freez-

ing will do no harm.

The second scheme for producing an over-all pattern on a wall consisted of an insized design with all surfaces plain and all curves arcs of circles. As before, the blocks measure eight inches by sixteen inches on the face and there are two units of the pattern on each block. The idea is to paint the sunken surfaces in oil, alternating red, blue, and green, leaving untouched the intervening flush surface of the cement except a rather small quantity of yellow when mixing to give it tone.

The design for this block was first made in clay and a plaster mould made from it which was put into the machine and laid, back against the face plate. The plaster mould was, however, first shellaced and oiled before the facing mixture was poured into the machine in order to prevent the cement from sticking to the plaster. The body of the block—cement 1, sand and gravel 5,—was then put in and tamped as before. Where a large number of blocks were to be made it would be cheaper and better to have a face mould made of iron.

MISCELLANEOUS.

There are a number of important points in regard to the best methods to pursue in the manufacture of cement blocks which have not been taken up here and which only could be treated adequately by a man of broad experience and of technical knowledge of concrete. The only thing published in concrete form on the subject of cement blocks is a paper by

Mr. Spencer B. Newberry entitled, "Hollow Concrete Block Building Construction" and contains paragraphs on the following points: Historical, Materials, Proportions of cement, water and aggregate, Mixing, Block Machines, Tamping, Handling, Hardening and Storage, Strength, Water Absorption, Color, Cost, and Use of Blocks in Buildings. All of these points seem to have been thoroughly investigated and well treated. Besides the above mentioned paper there were published in the October number,1905, of the"Cement Age" three prize articles on "The Manufacture of Concrete Blocks and Their Use in Building Construction." One of these contains some very valuable drawings and another is particularly valuable for its information regarding patent-rights.

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